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PHYSIOLOGICAL AND PSYCHOLOGICAL CHARACTERISTICS OF SUCCESSFUL COMBAT CONTROLLER TRAINEES

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14. ABSTRACT. The USAF Combat Controller (CCT) training pipeline is extremely arduous and historically has an attrition rate of 70-80%. The primary objective of this study was to identify the physiological, psychological or demographical characteristics associated with successful progression through the CCT pipeline program. Our findings revealed the following mean characteristics of 109 CCTs who completed Phase I of the pipeline and achieved their 3-level rating: 23 years old, 1.8 m tall, 81 kg, 12% body fat, VO_2max of 59 ml/kg/min, vertical jump of 62 cm, able to generate 11.4 W/kg peak power and 9.3 W/Kg mean power during Wingate tests, overall mental toughness rating of 8 (out of 10) with high levels of extraversion and conscientiousness and low levels of neuroticism. Football was the most popular competitive sport played in high school, followed by track, wrestling, and baseball. These results may prove useful in refining the selection criteria and in designing training for CCT trainees.						
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List of Symbols, Abbreviations, and Acronyms

711 HPW – 711 Human Performance Wing
AFRL – Air Force Research Laboratory
ACSM - American College of Sports Medicine
BAT - Battlefield Airman Test
bpm – Beats per Minute
CCT - Combat Controller
Cm – centimeters
Et al. – “and others” (Latin)
HR – Heart Rate
IPIP - International Personality Item Pool
J - Joules
kg – kilograms
L.min-1 - Liters per minute
m – meters
microL – microliters
mL.kg-1.min-1 – milliliters per kilogram per minute
mmol.L-1 – millimoles per liter
mph – miles per hour
MTQ 48 - Mental Toughness Questionnaire 48
n – number of subjects
RER - Respiratory Exchange Ratio
rpms – revolutions per minute
s or secs – seconds
SCUBA – Self-Contained Underwater Breathing Appartus
SD - Standard Deviation
STTS - Special Tactics Training Squadron
U.S. – United States
U.S.A.F.A - United States Air Force Academy
VO2max - Maximal Oxygen Uptake
W – Watts
W/kg – Watts per Kilogram
WAnT - Wingate Anaerobic Test

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The authors wish to thank Major Chris Larkin, Mr. Bill Lyons and Mr. Vint Anderson, Combat Athlete Cell, Special Tactics Training Squadron, Hurlburt Field, Florida for providing access to the trainees, assistance with data collection and all-around support for this project.

Executive Summary

Purpose:

The primary objective of this study was to identify the physiological performance, psychological and demographic characteristics associated with successful progression through the Combat Controller (CCT) pipeline program and to compare these characteristics to various norms.

Methods:

A battery of physiological measurements, biographical information, and psychological tests were used to determine the profile of a successful CCT trainee. These measures were chosen on the basis of being standard physical fitness parameters, CCT-specific physical attribute indicators or validated psychological surveys. A multiple of physical tests served as measurements for cardiovascular endurance (VO_2max and running economy), "anaerobic" capacity (Wingate power and loaded anaerobic endurance treadmill tests), body composition skinfolds measurements, power (Wingate and vertical jump), and reaction time (Makoto eye-hand test.) Each test was conducted using a standardized protocol. Psychological characteristics were explored through use of the International Personality Item Pool (IPIP-NEO) and the Mental Toughness Questionnaire 48 (MTQ 48).

Results and Conclusions:

CCT trainees who recently attained their 3-level rating demonstrated the following means: body fat percentage of 12.3%, VO_2max of 58.9 $mL \cdot kg^{-1} \cdot min^{-1}$, vertical jump of 62.3 cm, Wingate test average power of 9.27 W/kg, and peak power of 11.39 W/kg. These results are much better than those of the average military recruit and, with the exception of body composition, compare favorably to most college athletes. CCT averaged 7.9 (on a 10-pt scale) for mental toughness. They displayed high mean scores for extraversion and conscientiousness and low scores for neuroticism and openness to experience. It may prove beneficial to select individuals with similar characteristics for CCT training and/or to design training programs with the goal of reaching the performance variables observed here.

INTRODUCTION

Objective

The primary objective of this study was to identify the physiological performance, psychological and demographic characteristics associated with the successful progression through the Combat Controller (CCT) pipeline program.

Background

Historically, the nearly 24-month U.S. Air Force CCT training pipeline has had an attrition rate over 70%. Primary reasons for this attrition include self-initiated elimination, failure to meet physical and academic standards, and both acute and chronic overuse injuries. To successfully navigate the training pipeline it appears that candidates must possess very high levels of motivation, physical fitness, and mental toughness. Identifying what levels of these attributes potential candidates require to be successful is of critical importance to reducing training attrition. Additionally, these attributes can be utilized to tailor training programs to best strengthen each individual and increase the likelihood for training completion.

Multiple studies have looked at predicting success in various military career fields and athletic performance. A recent study by Simpson et al (2006) looked at multiple physiological variables and performance markers from three physical tests. They concluded that two tests, the maximal treadmill test and two-mile backpack run were useful performance indicators and could be employed in the screening and selection of potential recruits. Pope et al. (1999) investigated 1,317 male Australian Army recruits to predict attrition in basic military training. The results revealed a strong negative association between higher fitness and risk of attrition. Similarly, psychological traits have been demonstrated to successfully predict, or at least correlate with, military and athletic achievement. Hartmann et al. (2003) administered three psychological measures to determine the predictive validity of training performance in 71 male applicants at the Naval Special Forces of Norway. Three Rorschach variables accumulated incrementally in the prediction of training completion. Psychological attributes of successful athletes have also been studied. Highlen and Bennett (1979) were able to identify qualifiers for the elite Canadian wrestling teams based on the athletes psychological profiles with an a 85 percent accuracy rate.

METHODS

Participants

A total of 109 CCT trainees, age 19-30, signed institutionally approved informed consent documents and were enrolled into the study. All trainees had successfully completed the first year of CCT training and achieved their 3-level status as an Air Force Combat Controller.

Facilities

Data collection was performed at the 720th Special Tactics Training Squadron (STTS) Physical Training Facility located at Hurlburt Field, FL. The STTS is responsible for the advanced skills training portion of the two-year CCT pipeline, producing operationally-ready combat controllers. Physical testing was incorporated into the pre-SCUBA phase of training, occurring during the first two months of the 12-month program. Test results were quickly analyzed and enabled the prescription of individualized exercise regimens.

Experimental Design

A battery of physiological measurements, biographical information, and psychological tests were used to determine the profile of a successful CCT trainee. These measures were chosen on the basis of being standard physical fitness parameters, CCT-specific physical attribute indicators, or validated psychological surveys. A battery of physical tests served as measurements for cardiovascular endurance (VO_2max and running economy), “anaerobic” capacity (Wingate and loaded anaerobic endurance treadmill tests), body composition (skinfold measurements), power (Wingate and vertical jump), and reaction time (Makoto tower test). Each test was conducted using a standardized protocol. Psychological characteristics were explored through use of the International Personality Item Pool (IPIP-NEO) and the Mental Toughness Questionnaire (MTQ).

Procedures

Body Composition. Subjects’ skinfolds were taken by Lange calipers (Cambridge Instrument, Cambridge, MD) at the standard chest, abdomen, thigh, subscapular, axillary, tricep and suprailliac sites. Three samples were taken and the average measure was used as the final value. The sum of these sites was used to determine body density (Jackson and Pollock, 1978). Body fat percentage was computed from body density using the Siri equation (Siri, 1961).

Cardiorespiratory Endurance. Maximal oxygen uptake (VO_2max) and running economy protocols were conducted on a Woodway DESMO treadmill (Woodway USA, Waukesha, WI). Each subject was fitted with a harness and a facemask to collect expired air for the Parvo Medics' TrueOne 2400 metabolic measurement system (Consentius Technologies, Sandy, UT). Subjects wore a Polar heart rate monitor transmitter (Polar Electro, Inc., New York, NY) around the chest to measure heart rate

(HR) response throughout the warm-up, test, and recovery phases of the protocols. After a one-minute rest period to verify transmitter communication, subjects performed a two-minute walk at 2.0 mph. Upon completion of the two-minute walk, treadmill speed increased to 7.0 mph at 0% grade. This speed and grade were maintained for three minutes to test for 7.0 mph running economy. Following that stage, the 7.0 mph speed was maintained while the grade increased by 2% increments every minute until it reached a 10% grade, after which it increased by 1% each minute until it reached a 15% grade or until subjects reached volitional fatigue. If subjects did not reach volitional fatigue at the maximum treadmill grade of 15 %, the treadmill speed increased by 0.5 mph every minute until the subject reached volitional fatigue. Once volitional fatigue was reached, the treadmill's speed slowed to a 2.0 mph pace at 0% grade to induce active recovery until his heart rate dropped below 120 bpm. At the one minute recovery stage, the subject received a finger stick for blood lactate collection (10 microL). These one-minute post-test lactates were analyzed using the Lactate Pro system (Arkray, Inc., Kyoto, Japan).

Battlefield Airman Test. The Battlefield Airman Test (BAT) is an anaerobic endurance test designed by the investigators specifically for this population using the Woodway Force 2.0 human powered treadmill. Subjects were fitted with a Polar heart rate monitor transmitter that monitored HR throughout the warm-up, test, and recovery phases. First, the subjects performed a two-minute warm-up on a Woodway Desmo treadmill striving to achieve a warm-up heart rate of 130-140 bpm. A Woodway waist belt was donned following the warm-up and attached to a force transducer on the rear post of the Force treadmill. The treadmill was pre-programmed with five pounds of resistance internally loaded to the treadmill belt to provide extra load and to help alleviate any balance issues. Subjects started to jog and then were given five seconds to achieve a self-selected speed above 7.0 miles per hour. The test continued until the subject could no longer maintain a speed greater than 7.0 mph. All subjects were given one warning to increase their speed if they dropped under 7.0 mph and the test was terminated if they couldn't increase their speed or when the subject dropped below 7.0 mph for the second time.

Wingate Tests. Each subject accomplished an upper body and lower body Wingate anaerobic test (WAnT) on a Monarch 894E Ergomedic Wingate Test Ergometer (Monarch, Seattle, WA). These instruments are specially designed systems with instantaneous loading and braking features. For the lower body test, the seat height was adjusted so that no more than five degrees of knee flexion was present when the leg was fully extended. Each subject performed a 3-5-minute warm-up period striving to achieve a warm-up heart rate of 130-140 bpm including two or three 5-second high revolution spins. Resistance for the test was set at 7.5% (lower body) and 5.0% (upper body) of the subject's body weight within a 0.1 kg resolution of resistance range. A Polar heart rate monitor transmitter monitored HR throughout the warm-up, test, and recovery. The WAnT consisted of a countdown phase and a 30-second (legs) or 15-second (arms) all-out pedaling phase. During the first five seconds of the countdown the subject pedaled at a comfortable cadence. At that point, subjects began pedaling at maximum speed at 1/3 peak resistance. When subjects' rpms exceeded

150, test resistance was added instantaneously by dropping the weight rack. At one minute post completion, subjects received a finger stick for blood lactate collection (10 microL). These one-minute post-test lactates were analyzed using the Lactate Pro system (Arkray, Inc., Kyoto, Japan). Because Wingate norms for elite athletes have not been firmly established we calculated initial norms for elite athlete upper body absolute and relative peak power using ½ standard deviation from the mean in each direction and published them here.

Reaction Time. Eye-hand reaction speeds were measured on the Makoto Sports Arena (Makoto USA, Centennial, CO) in reactive and proactive modes. A one minute rest was given between tests. Each test was performed twice and the better of the two scores was recorded. In the proactive test, the targets on a single tower remained activated until hit by the subject. The results of the proactive test were the average time to hit each target. In the reactive test, targets on a single tower only remained active for 0.74 seconds. If the subject did not hit the target in the allotted time, then the occurrence was recorded as a miss. The results of this test were the percentage of targets hit and the average time to hit each target. There are no published norms for eye-hand reaction on the Makoto. Therefore, we calculated initial norms for elite athlete upper body absolute and relative peak power using ½ standard deviation from the mean in each direction and published them here.

Vertical Jump. A Vertec (Questec Corp., Northridge, CA) vertical measuring device was used to measure vertical jump height. Standing height of the subject was taken with one arm fully extended upward. Then the subject was asked to jump up to touch the highest possible vane while keeping both feet on the ground before starting the jump. Countermovement was allowed but approach steps were not. The subject continued jumping, with brief rest periods between jumps, until the peak height stalled for two consecutive jumps. Jump height was the difference between standing height and peak jumping height.

Psychological Testing. The International Personality Item Pool Representation of the NEO PI-R™ (IPIP-NEO, Dr. John A. Johnson, Penn State University) compares a subject on each of the five broad domains of the Five Factor Model of Personality to other individuals of the same sex and age in the United States. These five domains are extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience. Each of the domains is then comprised of six sub domains to give a more detailed description of their personalities. The results do not reveal hidden, secret information about the subject nor does it assess serious psychological disorders. The subjects completed the 120-item computerized questionnaire at the beginning of their participation in the study.

The Mental Toughness Questionnaire 48 (MTQ 48; Clough et al., 2002) assesses a subject's ability to withstand pressure in a range of environments. This 48-question written test measures the different elements of performance related characteristics in four core components: challenge, control, commitment, and confidence. Each subjects' answers were input into the MTQ 48 database and used to create a Coaching Report describing each subject's level of mental toughness. This Coaching Report provides trainers and coaches with a narrative about an individual's leadership style and offers coaching suggestions that will help the trainer or coach to better understand their trainee or team. The subjects completed the questionnaire both at the beginning and at the end of their participation in the study. Only the initial survey was used for this analysis due the lack of differences between test results.

Trainees also completed a short demographics questionnaire that asked about their history of participation in organized sports.

Statistical Analyses

Descriptive statistics were used to provide the physical and psychological profile for each parameter that was measured. Mean ± standard deviation (SD) were calculated and compared with appropriate normative data.

RESULTS

Table 1 summarizes the means and standard deviations for age, height, weight, and body composition. Ages ranged from 19 to 30 years. Height and weight ranged from 1.68 m to 1.94 m and 65.0 to 95.5 kg respectively. Percent body fat ranged from 3% to 20%.

Table 1. Demographic and body composition results

	Age	Height (m)	Weight (kg)	% Body Fat
Mean	23.3	1.78	80.82	12.39
SD	2.9	0.06	6.56	3.08

Table 2 shows means and standard deviations for the cardiovascular measures of VO_2max in both relative ($mL{\cdot}kg^{-1}{\cdot}min^{-1}$) and absolute terms ($L{\cdot}min^{-1}$), maximal heart rate (bpm), maximal respiratory exchange ratio (RER), and running economy ($mL{\cdot}kg^{-1}{\cdot}min^{-1}$). Relative, absolute, and running economy VO_2 max ranged from 50.2 to 70.5 $mL{\cdot}kg^{-1}{\cdot}min^{-1}$, 3.88 to 6.07 $L{\cdot}min^{-1}$ and 27.4 to 45 $mL{\cdot}kg^{-1}{\cdot}min^{-1}$ respectively. Maximal heart rate values ranged from 182 to 216 beats per minute while max RER values ranged from 1.12 to 1.38.

Table 2. Treadmill VO2max and running economy results

	VO_2max ($mL{\cdot}kg^{-1}{\cdot}min^{-1}$)	VO2max ($L{\cdot}min^{-1}$)	Maximal Heart Rate (bpm)	Maximal Respiratory Exchange Ratio	Running Economy ($mL{\cdot}kg^{-1}{\cdot}min^{-1}$)
Mean	58.90	4.75	196	1.24	35.59
SD	4.58	.44	8.08	.05	2.41

Table 3 displays means and standard deviations for the Makoto proactive reaction time and percentage of targets hit during the reactive test. Scores for proactive reaction time ranged from 0.38 to 0.75 s. The percentage of targets hit during the reactive test ranged from 24% to 100%.

Table 3. Eye-Hand reaction time and accuracy results

	Proactive Reaction Time (s)	Reactive Accuracy (% hit)
Mean	0.57	0.61
SD	0.06	0.17

Table 4 displays means and standard deviations for the "anaerobic" and power tests.

Table 4. Battlefield Airman Test (BAT), Wingate tests, and vertical jump results

	BAT distance (m)	BAT Work (J)	Lower Wingate Peak Power (W/kg)	Lower Wingate Peak Power (W/kg)	Upper Wingate Peak Power (W/kg)	Upper Wingate Mean power (W/kg)	Vertical Jump (cm)
Mean	267.02	9.40	11.39	9.27	8.06	6.37	62.26
SD	75.97	2.29	1.65	0.83	1.36	0.79	8.53

Because Wingate norms for elite athletes have not been firmly established we calculated initial norms for elite athlete upper body absolute and relative peak power (see tables 5 & 6.)

Table 5. Combat Athlete Lower Body Absolute Peak Norms (W)

	STTS Trainees	USAFA Athletes
Elite	1101	1163
Excellent	1044	1127
Above Average	986	1056
Average	929	950
Below Average	872	844
Fair	815	744
Poor	758	739

Table 6. Combat Athlete Lower Body Relative Peak Norms (W/kg)

	STTS Trainees	USAFA Athletes
Elite	13.86	13.74
Excellent	13.11	13.39
Above Average	12.36	12.70
Average	11.61	12.00
Below Average	10.87	11.31
Fair	10.12	10.27
Poor	9.37	9.57

Table 7. Combat Athlete Upper Body Absolute Peak Power Norms (W/Kg)

	STTS Trainees
Elite	816
Excellent	764
Above Average	713
Average	661
Below Average	610
Fair	559
Poor	507

Table 8. Combat Athlete Upper Body Relative Peak Power Norms (W/Kg)

	STTS Trainees
Elite	10.08
Excellent	9.47
Above Average	8.85
Average	8.23
Below Average	7.62
Fair	7.00
Poor	6.39

Table 9 displays our calculated norms for CCT trainees for the BAT.

Table 9. BAT Anaerobic Endurance Initial Norms (yards)

	STTS Trainees
Elite	371.19
Excellent	337.83
Above Average	304.47
Average	271.10
Below Average	237.74
Fair	204.38
Poor	171.02

Table 10 displays our calculated norms for CCT trainees for the Makoto reaction time tests.

Table 10. Eye-Hand proactive and reactive Norms

	Proactive (sec)	Reactive (% correct)
Elite	.44	87%
Excellent	.47	78%
Above Average	.50	70%
Average	.53	61%
Below Average	.56	53%
Fair	.59	44%
Poor	.62	36%

Table 11 displays means and standard deviations for the post-test peak lactate values from the “anaerobic” test.

Table 11. Peak Lactate Values

	Post VO2 max Peak Lactates ($mmol \cdot L^{-1}$)	Post BAT Peak Lactates ($mmol \cdot L^{-1}$)	Post Upper Body Wingate Peak Lactates ($mmol \cdot L^{-1}$)	Post Lower Body Wingate Peak Lactates ($mmol \cdot L^{-1}$)
Mean	12.88	13.60	9.18	10.72
SD	2.88	3.0	3.91	3.21

Table 12 shows the results of mean and standard deviation for the International Personality Item Pool five domains: extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience.

Table 12. International Personality Item Pool results

	Extraversion	Agreeableness	Conscientiousness	Neuroticism	Openness to Experience
Mean	77.79	44.70	78.99	19.82	23.33
SD	18.46	22.16	18.62	15.71	20.92

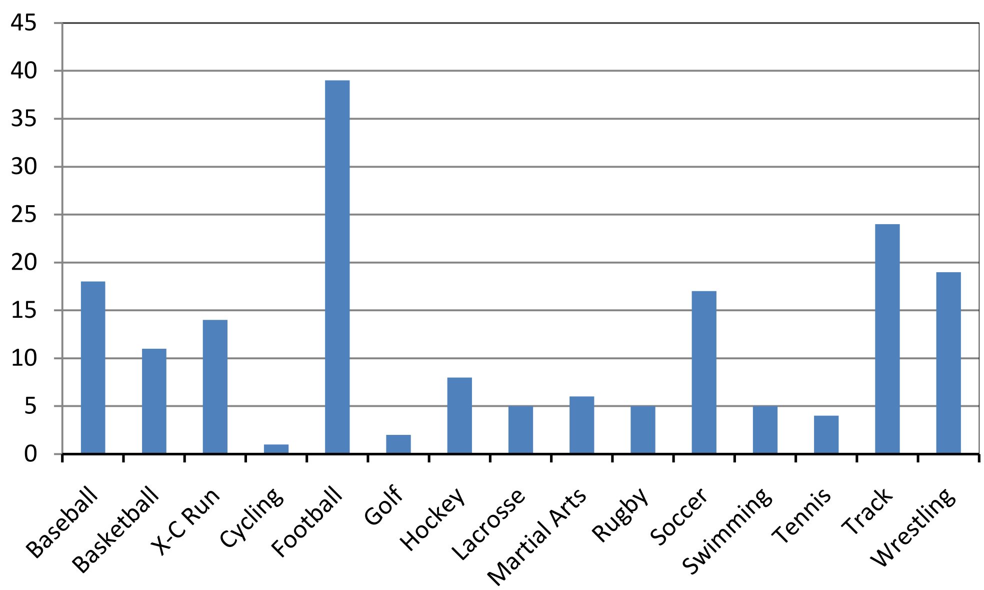
Table 13 shows the results for each of the core components of the Mental Toughness Questionnaire 48 and their overall mental toughness.

Table 13. Mental Toughness Questionnaire 48 results

	Overall Mental Toughness	Challenge	Commitment	Control	Confidence	Average less Overall Mental Toughness
Mean	7.9	7.0	8.0	7.3	7.5	7.3
SD	1.6	1.8	1.6	1.8	1.7	1.3

Of 23 sports listed on the demographics survey, football was the most common competitively played sport in high school, college or with a competitive club, followed by soccer, track and baseball. Figure 1 displays the frequencies for the most commonly played 15 sports.

Figure 1. Frequency distribution of commonly played sports (n = 109)



DISCUSSION

Due to the extreme physical demands of CCT pipeline training, we expected successful CCT students to possess much higher than average measures of physical fitness. Anecdotally, it is well established that only the very fit are able to adapt to the demands of CCT pipeline training. The results of this investigation confirmed that, as the performance measures observed here compared very favorably to established norms and are even better than those of many athletic/sports and other military populations.

CCT trainees' mean percent body fat was measured at 12.3%. That value is at approximately the 70th percentile according to normative data described in the American College of Sports Medicine's (ACSM) Guidelines for Exercise Testing and Prescription (Armstrong et al., 2000). The fact that their mean body fat percentage was not lower is likely due to the fact that CCT students undergo a large amount of swim training and that they are not strictly endurance athletes who are simply running 10-12 miles per day. The swim training is often done in relatively cold water. There is evidence that competitive swimmers have higher body fat levels than competitive runners (Jang et al., 1987), and that cold water swimming increases appetite and caloric intake which can result in higher body weights and lower body densities (White et al., 2005). A range of 6-12% body fat is generally considered a good range for most elite athletes and the trainees fall on the high side of this range.

Their mean VO_2max (58.97 $mL \cdot kg^{-1} \cdot min^{-1}$) places the CCT trainees well above the 90th percentile in the ACSM standards (Armstrong et al., 2000) and those of the National Strength and Conditioning Association (Baechle and Earle, 2000). That score is approximately 10.0 $mL \cdot kg^{-1} \cdot min^{-1}$ higher than that observed in most other published data of military personnel (Harman et al., 2008; Thomas et al., 2004; Sharp et al., 2002), 5.0 $mL \cdot kg^{-1} \cdot min^{-1}$ higher than college football skill players (Gulbin, Faik, Mehmet Zeki, 2009), and is roughly comparable to that of university-level soccer players (Arnason et al., 2004).

Impressive means for VO_2max were generally expected given the amount of endurance training performed in the CCT pipeline. However, we also observed better strength/power capability than one might have expected as evidenced by vertical jump and Wingate test results. CCT students' mean vertical jump measured 62.3 cm, roughly equivalent to that of high school football running backs and receivers, and recreational college athletes (Baechle and Earle, 2000). CCT students also scored quite high on Wingate tests. Mean average power was 9.27 W/kg. They averaged a peak power of 11.39 W/kg. These are above the 90th percentiles for males of 8.24 and 10.89 W/kg for average and peak power, as established by Maud and Schultz (1989). The CCT trainees compared very well in lower body absolute (W) and relative (W/kg) peak power to cadet athletes (football, lacrosse, baseball, etc) at the United States Air Force Academy (see tables 5 & 6).

The Battlefield Airman Test (BAT) is a new anaerobic endurance test developed specifically for this population. The initial norms for the population are presented in Table 12. There was a consensus among the trainees and STTS instructors during informal feedback sessions that the BAT accurately represented what a CCT will experience in the field. Although CCT physical training has not traditionally included much strength or power training, much of their operational training includes a substantial amount of power movements such as loaded jumping and high-intensity running. The CCT is required to maintain a high intensity over several minutes as they fast rope down to the ground from the helicopter and then move to secure their position. Some CCT instructors have begun to incorporate more strength and power exercise in their physical training programs.

The high level of physical fitness demonstrated by successful CCT trainees was expected. Trainees with poor or moderate levels of physical fitness would likely be unable to adapt to the rapidly increasing physical stresses of CCT pipeline training. Previous research (Pope, 1999) has clearly indicated a strong negative association between fitness and risk of attrition in military training and between fitness and injury during athletic training (Arnason et al., 2004). Similar associations can be seen for certain psychological characteristics of individuals undergoing difficult training (Hartmann et al., 2003). Successful CCT trainees displayed high levels of several of these characteristics.

The IPIP found that CCT trainees fall within the highest 30% of population scores for extraversion and conscientiousness. Highly extraverted individuals enjoy being around others, are full of energy, are action-oriented, express positive emotions, and look for opportunities for excitement. Facets of extraversion include friendliness, gregariousness, assertiveness, and excitement-seeking. It stands to reason that this component is high for combat controller trainees because they must stay positive even in situations that look bleak. Their successful completion of training and later, their lives and the lives of their teammates will depend upon it. The benefits of these individuals scoring high in the conscientiousness domain (mean = 78.99), are that they avoid trouble, achieve success through purposeful planning and persistence, and are seen by others as intelligent and reliable. Facets of conscientiousness are self-efficacy, orderliness, dutifulness, achievement striving, self-discipline, and cautiousness (Goldberg et al., 2006). These qualities are also vital to CCTs as they must excel as both leaders and followers and need high levels of internal motivation. Both extraversion and conscientiousness are critical components to working effectively in the types of small but highly dynamic teams in which the CCTs operate.

The trainees had scores comparable to the lower quartile of U.S. adult males in neuroticism and openness to experience. Facets of neuroticism include anxiety, anger, depression, self-consciousness, immoderation, and vulnerability. Individuals that score low in this area are less easily upset and are less emotionally reactive. They tend to be calm, emotionally stable, and free from persistent negative feelings. Obviously, these traits would be detrimental in combat controllers due to their need to stay calm and focused in difficult situations. Openness to experience distinguishes the cognitive style differences of highly creative people from those that are down-to-earth, conventional people. The facets of openness to experience include imagination, artistic interests, emotionality, adventurousness, intellect, and liberalism. Scoring lower in this area, as the trainees did, indicates having narrower, common interests, and preferring the plain, straightforward, and obvious over the complex, ambiguous, and subtle. It may be that this trait is common among combat controllers because although improvisation is an important skill, generally they must make decisions quickly and as practically as possible. Their training teaches them to keep things simple and easily accomplishable rather than complex and time consuming. Clough et al. (2002) found that individuals who tend to be sociable and outgoing; they are able to remain calm and relaxed, are competitive in many situations and have lower anxiety levels than others are also mentally tough.

High levels of extraversion have been associated with high levels of mental toughness (Clough et al., 2002). Our results support that association as, in addition to observing high levels of extraversion, we scored CCT trainees' mean mental toughness at 7.9 on a 10-point scale. It is not surprising that trainees had high scores for overall mental toughness. Trainees who lack mental toughness are unlikely to complete the first year of the grueling CCT training pipeline. Individuals with an overall mental toughness score of that level have confidence in their ability to take on and succeed at demanding tasks. They can deal with unforeseen circumstances without undue stress, are unlikely to give up, and see difficult situations as a challenge or opportunity for personal development rather than a threat to their security. They are in control of their emotions and can cope with difficult events, staying calm and stable under pressure (Clough et al., 2002).

We found an overall mental toughness score of 9 for the mode (26.42%) among trainees. Individuals in this category are able to cope effectively with most of life's challenges, and will use them as a way to enhance their personal development (Clough et al., 2002). Occasionally they will take on more challenges than they can handle, but unlike an individual with a score of eight, these individuals are able to complete the task even under difficult conditions, finding different ways to motivate themselves from within. This supports Maddi's (2007) research findings that military personnel undergoing hardiness training increase their motivation to execute the transformational coping and effective self-care needed to overcome stressful circumstances. This is strikingly identical to the mindset the CCT training pipeline teaches and reinforces. Successful trainees demonstrate high levels of self-confidence and are self-assured. Their peers see them as high achievers, determined to succeed at a task even when the task is very difficult and others have given up or failed.

There has been a wealth of evidence that individuals who possess high levels of mental toughness and/or hardiness are better physical performers. Hardiness is closely related to mental toughness and is defined as a set of personal characteristics that provide the courage and strategies to turn stressful circumstances into opportunities for enhanced performance, leadership, conduct, health, and psychological growth (Maddi, 1987, 2002). Sheard and Golby (2010) found that mental toughness, hardiness, focus, optimism, and self-belief are the crucial psychological characteristics that distinguish elite-level sport performers from their sub-elite counterparts. Other research (Highland and Bennett, 1979; Sheard, 2009) has indicated that superior mental toughness is highly related to successful sports performance. Moreover, Crust and Clough (2005) have demonstrated a significant correlation between mental toughness and physical endurance. Considering these results and the physical and psychological stress of the CCT pipeline, it is unsurprising that most successful CCT trainees possess high levels of mental toughness.

CONCLUSIONS

This research program investigated the physiological performance, physical and demographic characteristics of combat controller trainees. The results of the investigation confirm that CCT trainees who have achieved a 3-level rating possess much higher than average levels of aerobic and anaerobic fitness, power, mental toughness, extraversion and conscientiousness. They possess lower than average levels of neuroticism and openness to experience. We submit that these characteristics can be used to improve future selection and training of CCT trainees. Selecting individuals with traits similar to those found here could profoundly reduce injury and attrition in the early stages of the pipeline. Similarly, designing training to move CCT candidates towards these means could potentially reduce attrition and result in 3-level CCTs who are better prepared to advance in their training.

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